COST Action MP1106: Smart and green interfaces- from single bubbles and drops to industrial, environmental and biomedical applications.

"Multiphase flows with/without phase change"

Zaragoza, 3rd and 4th October 2013

Program and abstracts

	THURSDAY 3rd October
9:00-9:30 h	**Registration**
9:30-10:00 h	**Workshop opening**
10:00-10:45 h	Plenary Session Holographic Measurement of Cavitation in Sliding Bearings *Jeremy Coupland*
10:45-11:15 h	**Coffee-Break**
11:15-13:00 h	Bubbles (Chair: N. Andritsos)
	Inviscid oscillations of constrained bubbles and drops *Jiri Vejrazka*
	Study of isolated bubbles and bubble clusters in co-current upward two-phase flow, *S. P. Evgenidis*
	Pool boiling at high heat flux and flow boiling in pipe *W. Bergez*
	Pendant drop technique for the characterization of homogeneous and Janus gold, *M. A. Cabrerizo Vilchez*
13:00-14:45 h	**Lunch**
14:45- 16:30 h	Polymers (Chair: Jiri Vejrazka)
	Effect of drag reducing polymers on two-phase stratified flow in horizontal and slightly inclined pipes, *N. Andritsos*
	Phase transitions in polymers and liquids in electric field gradients *Yoav Tsori*
	Digestibility of a beta-lactoglobulin in bulk and adsorbed at fluid interfaces: effect of pulsed light processing, *J. Maldonado*
	Why superhydrophobic surfaces are smart? A method to prepare a type of SHS and how to test them, *I. Malavasi*
16:30- 17:00 h	**Coffee-Break**
17:30 h	Optional Laboratory visit
21:00 h	Workshop Dinner

	FRIDAY 4th October
9:00-9:30 h	**Gender Balance issues** *María Villarroya*
9:30-10:00 h	**Career development** *Mª Luisa Sarsa*
10:00-10:50 h	Deposition (Chair: Yoav Tsori)
	Heat transfer between hard ceramic particles and air plasma jet at multiphase flow in circular tube, *Mindaugas Milieška*
	Aerosols produced in electronic cigarette (EC) and their expected deposition in the respiratory system, *Tomasz R. Sosnowski*
10:50-11:30 h	**Coffee-Break**
11:30-13:00 h	Techniques (Chair: M.A. Cabrerizo- Vílchez)
	Plasma synthesis, characterization and catalytically evaluation of hard oxide catalysts for CO, NO_x reduction of combustion gases *Romualdas Kėželis*
	Like-doublet impinging liquid jets interactions in low gravity *Francesc Suñol*
	Inner flow and free-surface movement characterization in an oscillating drop, *Julia Lobera*
13:00-15:00 h	**Lunch**

Holographic Measurement of Cavitation in Sliding Bearings

Jeremy Coupland, Laura Angélica Arévalo Díaz, Tian Tang

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It is well known that cavities of vapour are observed when the dynamic pressure falls below the vapour pressure in a fluid flow and occurrence of cavitation bubbles is a major concern in the design of pumps and impellors as rapid bubble collapse and associated rises in pressure lead to rapid wear and premature failure[1]. It is less well known that cavitation also occurs in shear flows that occur between lubricated surfaces – although this was noted by Newton whilst observing the rings between a rolling convex lens and a wetted plane glass surface[2]. Although micro-cavitation of this type has been linked to wear, particularly in plain journal bearings, it also has the positive effect of increasing the load capacity[3] and for this reason deserves careful consideration.

This paper discusses preliminary work to record and measure cavitation within a simple sliding contact bearing using the holographic microscope shown in figure 1 using a pulsed Nd:YLF laser. A glass bearing was constructed using a plane glass microscope slide moving at approximately 2mm/s in a direction normal to the axis of a fused silica cylindrical lens.

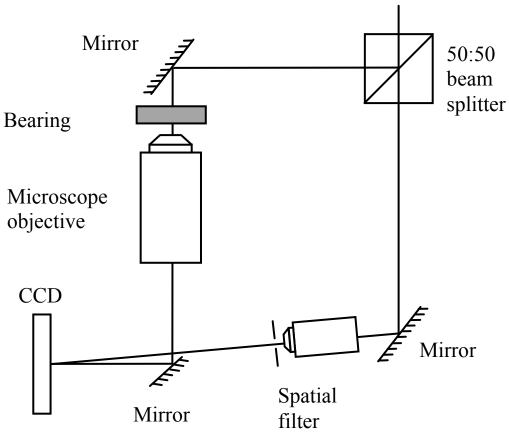

Figure 1. Holographic Microscope

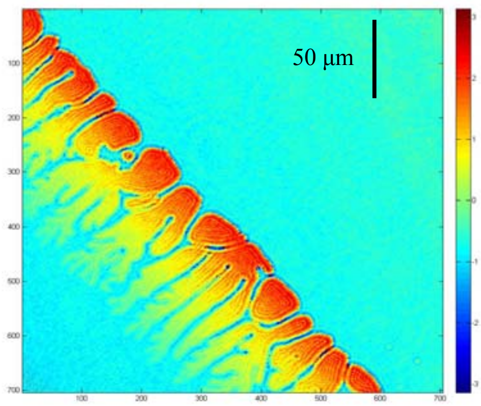

Figure 2. Cavitation Bubbles (Phase Map)

Using vegetable oil as the lubricating fluid a holographic video image (2672x4008 pixels @ 5.22 fps) was taken. Figure 2 shows the phase difference between a pair of holograms before and after the onset of cavitation. Although this preliminary analysis clearly shows where the cavitation bubbles are formed and that they increase in thickness as the oil film thickness increases it is not possible to determine whether or not the bubbles cover the entire gap between the bearing surfaces or indeed what the film thickness actually is. More extensive analysis that takes into account the effects of multiple scattering is planned for this purpose.

[1] Young F.R, Cavitation (1989) . McGraw-Hill.

[2] Newton, I, Optiks, (1952) Dover Publications, New York, p 207.

[3] Dowson, D. and Taylor, C., (1979). Cavitation in Bearings. *Annual Review of Fluid Mechanics*, vol. 11, no. 1, pp. 35-65

Inviscid oscillations of constrained bubbles and drops

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In the instruments for measurements of the interfacial elasticity and viscosity, shape oscillations of the bubble or drop may occur when the drop is forced at higher frequencies. For better understanding of these shape oscillations, a linear inviscid theory is developed using variational principles[1] (via Lagrange's equations and Lagrange's lambda-multipliers). The theory allows determining eigenmodes (i.e. eigenfrequencies, eigenmode shapes and damping of eigenmode oscillations), but also response of the bubble shape to a motion of its support or to volume variations. Present theory covers also the cases previously analyzed by Strani and Sabetta[2] and Bostwick and Steen[3]. It can be applied to both bubbles and drops. Overall, the theory is flexible, as it can easily adapt to any type of constraints, and compared to previous treatments, it is also easy and intuitive.

The theory prediction has been compared to experiments. Good agreement is found for the case of small bubbles, which have spherical static shape. Experimental results for larger bubbles and drops deviate from the theory, as a neck is formed. It is shown that this deviation correlates well with a ratio of bubble volume to the volume at its detachment.

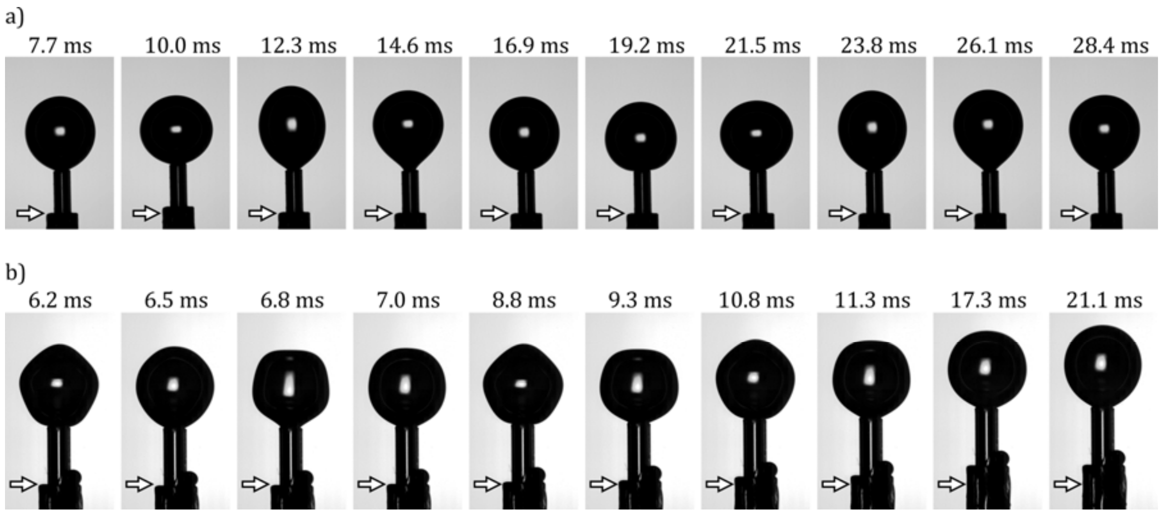

Figure: High-speed record of a ubble oscillating at a tip of capillary, a) D = 1.48 mm, bubble oscillates mostly at first eigenmode, b) D = 1.19 mm, oscillates mostly at third eigenmode

Acknowledgement: This research is supported by Ministry of Education, Youth and Sports (project no. LD13018).

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[3] Bostwick, J. B., Steen, P. H. (1995): Capillary oscillations of a constrained liquid drop. *Phys Fluids* **21**, 032108.

Study of isolated bubbles and bubble clusters in co-current upward two-phase flow

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This study is a complementary work to PhD Thesis of Evgenidis[1] that dealt with the development of an ultra-sensitive, non-intrusive electrical technique for bubbles detection and characterization in astronauts' bloodstream during Decompression Sickness (DCS). Evgenidis conducted in-vitro tests in a fully automated flow loop capable of generating co-current upward bubbly flow of various gas/liquid flow rates and bubble sizes that resembles blood flow with bubbles during DCS, employing a Newtonian fluid for rheological simulation of human blood. The objective of the present work is to extend the acquired knowledge utilizing a non-Newtonian fluid as a blood analogue, because blood is a complex multiphase system which in general exhibits non-Newtonian behavior. Experiments were conducted for the same conditions in the aforementioned flow loop. Preliminary tests showed that an aqueous solution of glycerol (35% v/v), containing 150 ppm of Xanthan gum and 0.9 % w/v NaCl simulates the rheological behavior of blood and electrical conductivity/pH as well. For study completeness, we applied also 0 and 1000 ppm of Xanthan gum concentration in order to compare better Newtonian and non-Newtonian behavior, while the effect of the surface tension was investigated by adding the surfactant Triton X-100. Gas volumetric concentration and bubble characteristics are measured by means of the novel electrical resistance technique[1] and a high resolution camera equipped with proper macro lenses. Bubbles presence causes an attenuation of the electrical signal and results obtained show a strong dependence of bubble characteristics on features of the acquired electrical signals. It is of particular interest that the presence of voluminous bubble clusters -instead of isolated bubbles- when 1000 ppm of Xanthan gum are added, cause intense signal fluctuations that follow a periodic pattern.

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Pool boiling at high heat flux and flow boiling in pipe

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Experimental studies are performed at IMFT in pool and convective boiling with a refrigerant HFE7000. A first study concerns the vapour bubble growth and detachment on a surface heated at a high heat flux up to the critical heat flux. The second study deals with flow boiling in a small tube and the characterisation of the flow patterns, wall friction and heat flux.

Bubble growth at high heat flux

Experiments on the onset of boiling crisis on an isolated nucleation site are performed to study the evolution of bubble cycle leading to wall drying. The heat supply (generation by Joule effect in an ITO deposit on a sapphire substrate), is rapidly increased from zero up to CHF (1 second), bubble growths are visualized with a high speed camera (5000Hz) and wall temperature is measured by IR imagery (1000Hz). Liquid HFE7000 is at saturation at 1bar. The results show an increase of the apparent contact angle with wall superheat corresponding also to a deviation of the curvature from its quasi-static value (equilibrium between surface tension and gravity). Dynamical effects in the bubble growth leading to an expansion of the bubble foot are visible when the CHF is approached.

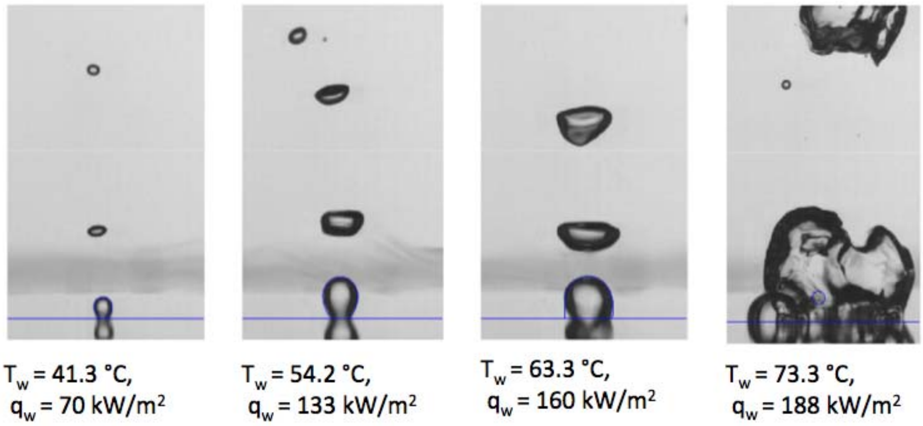
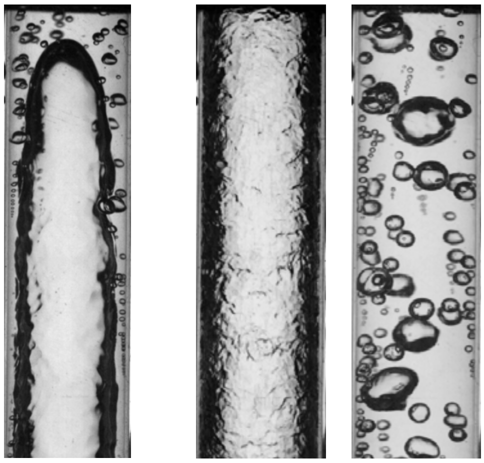


Figure 1: Evolution of the bubble size at detachment versus wall temperature and heat flux up to the boiling crisis (right image) – T_{sat}=36°C

Flow boiling in tube

Experiments are performed in a sapphire tube of 6mm diameter covered outside by a thin ITO coating heated by Joule effect. This test section is transparent and high-speed video pictures of the flow allow to determine the flow patterns depending on the mass flux and vapour quality. Pt100 probes measure the temperature of the heated wall and thermocouples measure the evolution of the fluid temperature. Thanks to these measurements the heat transfer coefficient can be calculated. The wall friction is deduced from pressure drop and void fraction measurements along the tube. Experiments are performed in upward flow and also in microgravity conditions reached during parabolic flights in an aircraft. Similar flow patterns: bubbly, slug and annular flows (Figure 1) are observed in normal and microgravity conditions. However significant differences are observed on the heat transfer coefficient, especially in annular flow. In upward flow the liquid film flowing at the wall is thicker than in microgravity and the heat transfer is smaller.



(*a*) (*b*) (*c*)

Figure 2: Flows pattern observed in microgravity
bubbly flow (*a*) – slug flow (*b*) – annular flow (*c*)

Pendant drop technique for the characterization of homogeneous and Janus gold 2-nm nanoparticles.

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The pendant drop technique enables the interfacial activity characterization of complex systems as gold nanoparticles modified with capping ligands [1]. The interfacial activity was characterized for hexanethiol- functionalized gold nanoparticles and Janus gold nanoparticles (2 nm-core iameter) composed of two regions of different hydrophilic character: hexanethiol and 2-(2-mercapto-ethoxy)ethanol) [2]. THF was used as an extension agent and the compression isotherms were built for each nanoparticle at the water-air and water-decane interfaces for different particle concentrations (Fig. 1). The particles were aggregated at the water-air and water-decane interfaces in sizes of hundreds of nanometers up to micrometers.

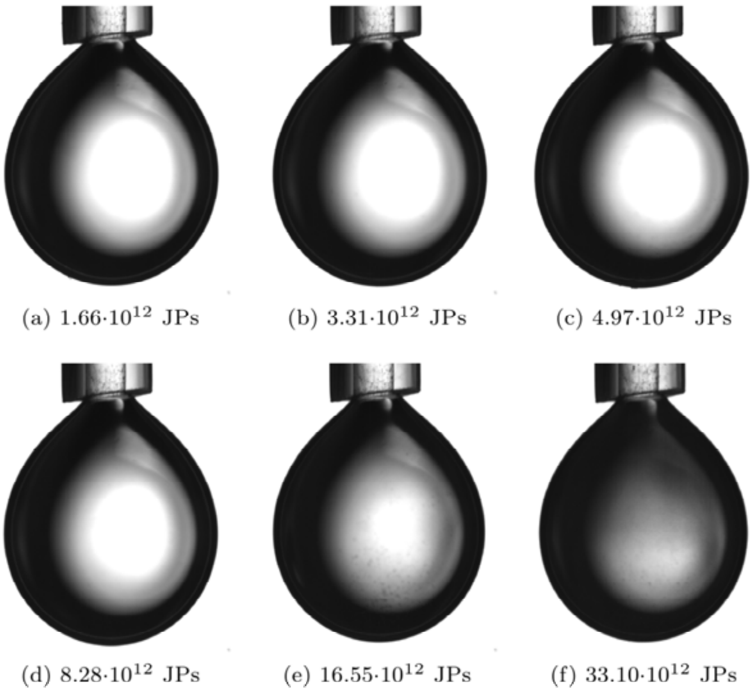

Figure 1: Water-decane interfaces with different Janus gold nanoparticles (JPs) deposited at the interface.

Acknowledgements: This study was supported by the ``Ministry of Science and Innovation" (project MAT2011-23339) by the ``Junta de Andalucía" (projects P08-FQM-4325 and P10-FQM-5977), and by US National Science Foundation (DMR-0804049). Authors thank to Dr. J.A. Holgado-Terriza, programmer of the software Dinaten used for surface tension measurements.

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[2] Pradhan S.; Xu L.; and Chen S., Janus nanoparticles by interfacial engineering, Adv. Funct. Mater. 2007, 17(14), 2385-2392.

Effect of drag reducing polymers on two-phase stratified flow in horizontal and slightly inclined pipes

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The addition of a minute amount of polymers to a turbulent pipe- or channel flow can result in a large reduction of the frictional drag. Although this effect has been known for almost half a century, the fluid dynamics community still has not been able to clearly identify the physical mechanism that causes this drag reduction. Apart from the obvious practical applications, it is interesting from a fundamental fluid dynamics point of view as well, since the study of polymeric drag reduction may give insight in turbulence itself. The injected polymer solution does not quickly mix with the mean flow and stays as a filamentous second phase over a long distance. It has been recently observed that the presence of filaments in solutions injected through wall slots and documented that these flows show greater drag reduction than would be realized if the polymer were uniformly distributed.

The main goal of this work is to investigate the effect of the addition of minor quantities of drag-reducing polymers in the liquid phase on the shape of interface in two-phase stratified flows in slightly inclined and horizontal pipes and, consequently, on interfacial friction factor and on pressure drop in the system. Experiments have been carried out so far in 13-m long pipe having a diameter of 0.024 m. A second pipe, 0.10 m in diameter, is almost complete. Preliminary results showed a delay in the appearance of two-dimensional waves and dampening of roll waves, resulting in a significant reduction of frictional pressure drop.

Phase transitions in polymers and liquids in electric field gradients

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We look at phase transitions in liquid mixtures in electric field gradients. For an initially-homogeneous mixture above the coexistence curve, large enough gradients of electric field can lead to a phase separation transition. We formulate this problem on the level of Poisson-Boltzmann theory and look at the statics and dynamics of this "electro prewetting" transition, including peculiar interfacial instabilities in purely dielectric liquids. When applied on simple fluids field gradients can lead to a nucleation of a gas bubble from a homogeneous liquid or to nucleation of a liquid drop from a homogeneous gas. The theory is extended to polar solutions where the preferential solvation of the ions in the liquids is crucial. We show that contrary to the classical DLVO behavior, neutral or even charged colloids can be stabilized by *addition* of salt. The theory is supported by experiments. We explore several interesting consequences of the phenomenon such as separation of liquids in microfluidic channels, and control of the spatial and temporal kinetics of chemical and biological reactions.

Digestibility of a β-lactoglobulin in bulk and adsorbed at fluid interfaces: effect of pulsed light processing

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Traditionally, the design of food products has been based, almost exclusively, on optimising formulation and physicochemical properties such as stability and texture. To systematically take into consideration the process of digestion in the assembly line of a food product is a novel approach which allows back engineering to reach an improved functionality of the product. Based on the physiological/physicochemical understanding of digestion, opportunities to affect the digestion profile, delivery and release of nutrients by food structure and composition are identified.

The proposition here is twofold. On one hand we present a new experimental approach where we study the effects of digestion on protein covered interfaces by interfacial dilatational and interfacial shear rheology. Multi subphase exchange device (OCTOPUS)[1] allows applying in-vitro digestion process in a single droplet and measuring interfacial tension in-situ (Figure 1a). Then, we apply the same in-vitro digestion process on a planar interface by flow injecting/extracting and record the interfacial shear parameters in-situ (Figure 1b). Combination of these experimental techniques provides important new aspects of the molecular mechanisms underlying enzymatic breakdown of protein structures during simulated gastrointestinal digestion.

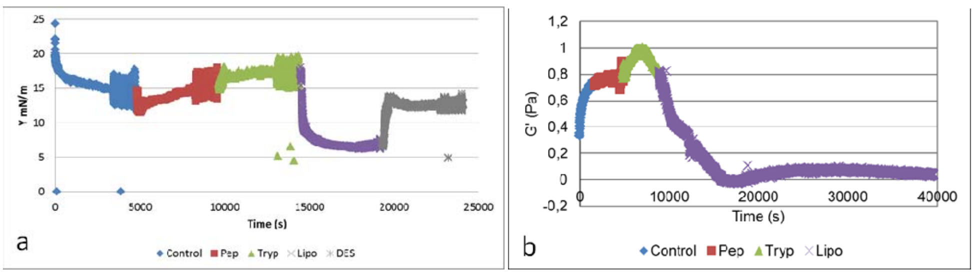

Figure 1: (a) Interfacial tension following in-vitro digestion onto adsorbed BLG (0.1 g/l) at the olive oil-water interface (b) Interfacial shear elastic modulus G' following in-vitro digestion onto adsorbed BLG (1 g/l) at the olive oil-water interface. Digestion process: Control (pH 7, 37ºC), Pep (pH 2,150 mM NaCl, 37°C pepsin:protein 1:20 w/w), Tryp (pH 7, 150 mM NaCl, 3 mM $CaCl_2$, 37°C, trypsin 0.42µg/ml, chimotrypsin 0,87 µg/ml), Lipo (pH 7, 150 mM NaCl, 3 mM CaCl2, 37°C, 0.16 g/l lipase+1 mM Bile Salts (52.7% NaTC, 47.3 % NaGDC)), DES (pH 7, 150 mM NaCl, 3 mM $CaCl_2$, 37°C)

On the other hand, the study has been designed to investigate the effects pulsed light processing on β-lactoglobulin (PL-BLG) on the digestibility as compared with native β-lactoglobulin (BLG). This is a novel treatment which enhances the overall strength of the interface and could facilitate the digestion process[3]. Probing the impact of this treatment on the digestibility of the protein layer can be useful in tailoring novel food matrices with improved functional properties such as decreased digestibility, controlled energy intake and low allergenicity.

Acknowledgements: This work has been sponsored by the EU-FP7-PERG07-GA-2010-268315-ColloDi, and projects JCI-2009-03823, MAT2010-20370, MAT2011-23339, P09-FQM-4698 P08-FQM-4325, P09-FQM-03099 (Junta de Andalucía) and CEI2013-MP-3 (Campus de Excelencia Internacional CEI-BioTic).

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2 E. Fernández, E., Artiguez, M. L., Martínez de Marañón, I., Villate, M., Blanco, F. J., Arboleya, J. C. (2012): Effect of pulsed-light processing on the surface and foaming properties of b-lactoglobulin. *Food Hydrocolloids*, **27**, 154-160.

Why superhydrophobic surfaces are smart? A method to prepare a type of SHS and how to test them

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[2] Laboratory of Thermodynamics in Emerging Technologies, Mechanical and Process Engineering Department, ETH Zürich, 8092 Zürich, Switzerland.

The paper describes why superhydrophobic surfaces (SHS) are smart and their possible application. We propose a synthesis to fabricate superhydrophobic surfaces using aluminum as substrate. The synthesis is performed in one step, thanks to simultaneous etching with NaOH and grafting with fluoroalkyl silane (FAS) molecules.

To define the wettability properties of a solid surface, static and dynamic tests are used. The static measurement (sessile drop method) regards the evaluation of the advancing contact angle, the receding contact angle and their difference (hysteresis). Normal and oblique impacts of water drops on superhydrophobic surfaces are used to investigate the dynamic of the phenomenon that may affect the wetting of the surfaces (e.g. transition from Cassie-Baxter to Wenzel state[1,2] is usually invoked to explain why, after a drop impact on superhydrophobic surfaces, the drop remains stuck on the surface, unable to rebound).

SHS-FAS are characterized by an advancing contact angle greater than 160° and an hysteresis rather than 10°. Drop impact tests on horizontal SHS-FAS surfaces showed that drop rebound occurs on the SHS-FAS for all impact speed (0.8 m/s < V < 4.1 m/s). No transition, from Cassie-Baxter to Wenzel state, occurs[3] in the range of Weber number $21<We<552$ ($We= (\rho v^2 d)/\sigma$, where ρ is the density of the liquid, v is the velocity of the drop, d is the droplet diameter and σ is the surface tension of the liquid).

Also, rebound time (time between impact and total rebound) was found to be independent from impact speed on SHS-FAS, as predicted by Quéré and co-workers[4].

Rebound always occurs on tilted SHS-FAS in all range of impact velocity (0.8 m/s < V < 4.1 m/s) and tilted angle (from 0° to 80°). The increasing of the tilt angle generally facilitates drop shedding and reduces drop rebound time[3].

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Heat transfer between hard ceramic particles and air plasma jet at multiphase flow in circular tube

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The mineral fibre formed using plasma technology has unique properties, such as resistance to high temperatures, low thermal conductivity, and high chemical stability. Because of suitable properties the ceramic fibres can be used for high temperature insulation and in production of various filtering materials. The certain composition ceramic fibre can serve as a catalyst.

One of the main factors which define the efficiency of the plasma fibrillation process in the straight plasma-chemical reactor is the heat transfer between the plasma flow and raw dispersive particles. The heat transfer depends on the plasma flow parameters, the construction of plasma-chemical reactor, the character of particle injection, the properties of dispersive particles and etc.[1] During the plasma fibrillation process the heat transfer takes place between the plasma flow, the dispersive particles and the walls of the reactor. One of the main objectives for the fibrillation process to be more effective is to minimize the heat losses to the reactor walls and increase the heat transfer to the dispersive particles. The analysis of the injected dispersed ceramic particle size, elemental composition and flow rate influence on the heat transfer was investigated. Experiments were performed without particle melting in the channel at plasma jet constant parameters. Experimental data showed that the intensity of heat transfer between the plasma flow and dispersive particles increases as the mass concentration of particles in the plasma flow increases and the size of the particles decreases. The increase of mass concentration of dispersive particles in the plasma flow from 6 to 24 % causes the decrease of the heat flux to the reactor walls from 2 to 9 %. The elemental composition of dispersive particles used in this work has no influence on the heat transfer.

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Aerosols produced in electronic cigarette (EC) and their expected deposition in the respiratory system

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Electronic cigarettes (ECs) became popular substitutes of traditional tobacco products. They are considered healthier as the aerosols they release do not contain harmful organics typically present in a combustion smoke. The "artificial smoke" produced by ECs is, in fact, a mist of droplets containing propylene glycol or glycerine. These droplets carry chemically purified nicotine into the lungs, however, as seen from the puffs exhaled by EC users, a substantial amount of this mist is exhaled. Therefore some aerosol with nicotine is released to the nearest surrounding of the EC user.

The aim of this study was to measure droplet size distributions in aerosol emitted from two types of ECs and compare the pressure required to activate the devices. Based on these data theoretical estimation of inhaled particle capture inside respiratory system was done based on a selected deposition model [1]. We tested two devices: eGo-W and eGo-CE5, both based on, so called, cartomizer-type vaporizing systems. Emitted aerosol was sucked with the rate of 10 L/min into the Spraytec inhalation chamber (Malvern Instruments, UK), where droplet size distribution was measured in the range of 100 nm – 900 μm. The pressure drop required to activate EC was measured in a separate tests using electronic manometer (Testo, Germany). The aerodynamic resistance was also measured for a conventional cigarette.

Both ECs produce particles smaller than 2 μm with a mass median diameter around 415-440 nm, however one product (eGo-CE5) emitted a slightly lesser mass of particles in a submicron range. Interestingly, both tested electronic cigarettes differ with internal aerodynamic resistance during drawing the vapor. By analogy to medical inhalers, the numerical value of EC internal resistance, R_D, was estimated, and these values are 1.74 and 1.58 $hPa^{0.5}$ min dm^{-3} for eGo-W and eGo-CE5, respectively. These numbers are substantially higher than in a conventional cigarette measured within this study (0.52 $hPa^{0.5}$ min dm^{-3}) and more than ten times higher than the resistance of typical medical inhalers [2]. It can be expected therefore that different aerosol flow rates in both ECs will be obtained with the same force of inhalation and this can also result in different aerosol deposition in the lungs.

Based on the deposition calculations it was found that total lung deposition of aerosol particles emitted from ECs is well below 25%, and the exact value depends on inhalation rate and depth, which can vary between products due to different aerodynamic resistance. Small differences in droplet size distribution in aerosols emitted from both tested ECs has also influence on the deposition pattern and its final value. In conclusions it can be stated that significant amount of inhaled mist is exhaled so the surrounding area can be contaminated with aerosol which contains nicotine. The influence of several factors (puffing frequency, cartomizer fill, inhalation dynamics) is planned to be investigated in the near future to better characterize the performance of ECs as the specific generators of aerosol intended for inhalation.

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Plasma synthesis, characterization and catalytically evaluation of hard oxide catalysts for CO, NO_x reduction of combustion gases

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The application of existing catalytic systems for exhaust gas treating based on the use of platinum group metals is limited. A novel conception of CO, SO_2, HC and NOx reduction in exhaust gas, using hard ceramic filament produced by plasma technology, was investigated. The study covers results of investigation of high temperature resistant zeolite filament production by plasma spray technology and it catalyst properties. The research on operating characteristics of plasma spraying system by investigation of optimal plasma generator and plasma chemical reactor, for hard ceramics processing, working parameters has been performed at atmospheric pressure. Optimal operating parameters for deposition of catalytic zeolite filament for wide range of catalytic applications and production of fine cleaning filters as well were obtained.

Determination of microstructure, elemental and phase composition of the resulting products was carried out using SEM , X-ray diffraction analysis, high speed camera and etc., respectively along with studies of microstructure, mechanical properties and thermal annealing of the material.

The date of obtained filament surface morphology and microstructure are presented. By the data of the X-ray diffraction study it has been determined that all the products obtained were amorphous materials with a small amount of crystalline phases. Catalysts properties of obtained zeolite filament were studied to. Preliminary data show that it could be used as catalyst for CO and NO_x reduction.

Like-doublet impinging liquid jets interactions in low gravity

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The effects of liquid flow rate and impact angle on the collision between like-doublet jets have been recently investigated in the low gravity environment provided by the ZARM drop tower. Tests were carried out with distilled water, injected through nozzles with an internal diameter of 0.7 mm. The liquid flow ranged between 20 ml/min and 80 ml/min for each nozzle, while the impact angle varied between 10º and 180º (frontal collision). Such a large parameter range have allowed us to observe different phenomena resulting from the jets collision: from droplets attached to the nozzles, to a non-uniform spatial distribution of bouncing droplets, coalescing droplets generating a single central droplet, coalescing jets, bouncing jets, liquid chains and liquid sheets.

We present observations of the structure of the jets, the breakup length, the generated droplet sizes and subsequent dynamics. High-speed movies revealed that the resulting structure of frontal colliding jets highly depends on the Reynolds and Weber numbers, and the proper alignment of the impinging jets. The collision between oblique jets can result in droplet dispersion, jet coalescence, jet bouncing or liquid sheets, depending on the impact angle and flow rate.

Inner flow and free-surface movement characterization in an oscillating drop

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In this work the three-dimensional inner flow in an oscillating drop and its free-surface movement was analysed by means of digital holography. A liquid drop was squeezed between two parallel glass plates. The glass was treated to be slightly hydrophobic (contact angle around 90º, with hysteresis around 10º). The plates were attached to the vertical axis of a mechanical shaker connected to a function generator that produces vibrations in a wide range of frequencies. As the vertical acceleration is increasing, different transitions can be observed for a flat squeezed drop. The velocity vector maps have been obtained for different droplet states. Figure 1 shows a top-view droplet image overlapped with the velocity vector map. In that case the drop shows azimuthal standing waves and oscillates between two different configurations in one period T_e, the time between the two configurations being $T_e/2$. The drop free surface changes during an oscillation can be also estimated from the free-surface diffraction pattern. In figure 2 the shadow limits are painted with colors, red meaning high z position, while blue means low z position.

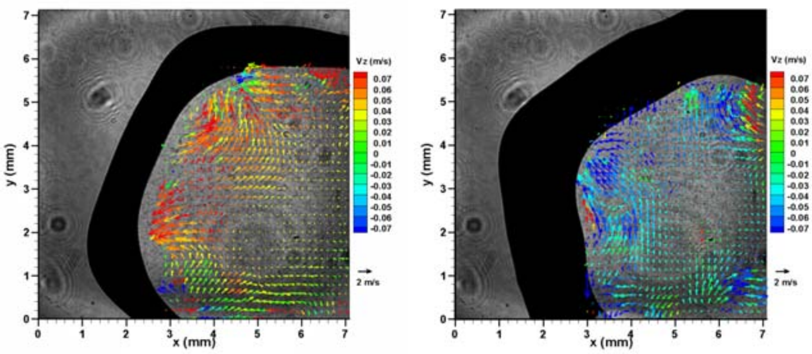

Figure 1: Velocity vector maps

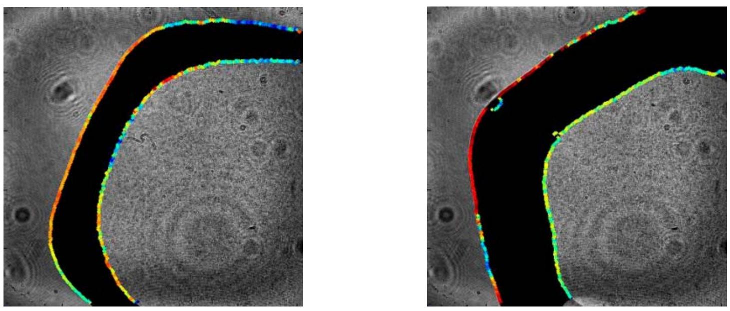

Figure 2: Free-surface position.

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Gender Policies at the Universidad de Zaragoza

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In the last century many changes in the gender balance in high education in Spain have occurred. We will proceed with an analysis from the government policies to the particular changes in the University of Zaragoza, comparing local situation with national and European one.

Situation of the gender impact at the University of Zaragoza would be presented, with an special focus on science faculty [1].

Finally more recent polices implemented by the Gender Equality Office would be presented [2]. Also the impact for the economic crisis would be considered.

[1] *Diagnóstico de la situación respecto a la igualdad de género de la Universidad de Zaragoza*. Observatorio de Igualdad de Género. Vicerrectorado de Relaciones Institucionales y Comunicación. Universidad de Zaragoza. 2011

[2] http://www.unizar.es/gobierno/vr_institucionales/observatorio/index.html.

Career development at the Science Faculty of the Zaragoza University

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Graduated students in scientific disciplines will face to a continuous learning and adaptation process along their career development. Academic contents cannot fill all this know-how, but academic activities should help the students to acquire this awareness. In this sense, the Sciences Faculty at the University of Zaragoza has a full and long-standing program of activities for students, aiming at showing real life career developments and easing the access into the labour market. It will be briefly presented.